

## Research article

# The northward expansion and some biological characteristics of Mediterranean spearfish, *Tetrapturus belone* Rafinesque, 1810, in the Aegean Sea, Türkiye

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**Abstract:** The Mediterranean spearfish, *Tetrapturus belone* is one of the top pelagic migratory predator and well-known around Tyrrhenian Sea. Due to the limited knowledge on its biology, ecology and distribution, each data related *T. belone* arouses curiosity. In the present study, two individuals were accidentally caught by commercial longlines and trammel nets in the Babakale coast and Mavra Island, North Aegean Sea, Türkiye. The lower jaw total length and weight of the 1st individual was determined as 1.7 meters and 30 kilograms, respectively. The morphometric and meristic characteristics, sex, maturity stage, and stomach content of 2nd individual was recorded. The individual measured as 1.55 meters in length, 13.15 kilograms in weight. The sex was determined as female and the gonad was detected as a developing stage. Garfish, *Belone belone* individuals of various sizes were detected as prey.

**Keywords:** Istiophoridae, Billfishes, Incidental Catch, North Aegean Sea, Stomach content

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## Introduction

Billfishes, large pelagic species are highly migratory and one of the top predatory marine fish species (Nakamura, 1985). Billfishes are known as family Istiophoridae, which arised from 11 species and 5 genus (Nelson, 1984). Among them, Mediterranean spearfish (*Tetrapturus belone* Rafinesque, 1810) is an endemic species that is generally distributed to the Mediterranean Sea (Nakamura, 1985; Collette & Graves, 2019). *Tetrapturus belone* is reported as a single representative species of the genus *Tetrapturus*

and the family Istiophoridae for the Türkiye Seas (Bilecenoğlu et al., 2014).

*Tetrapturus belone* is not evaluated as commercial fisheries, directly. (Di Natale et al., 2022). This species is caught incidentally or bycatch especially between the catches of driftnet and longline fisheries (Nakamura, 1985; Collette et al., 2023). The status of this species has not yet been assessed by the International Commission for the Conservation of Tuna-like Species (Malara et al., 2024) due to the lack of sufficient data. Also, this species is assessed as least concern by the IUCN Red List of Threatened

Species (Collette et al., 2023). According to the scarce biological knowledge, this species is an epipelagic fast swimmer fish and lives at depths of 0-200 m (Romeo et al., 2009; Collette et al., 2023). It mainly feeds on epipelagic fish and cephalopods (Castriota et al., 2008; Romeo et al., 2009; Romeo et al., 2012; Arostegui et al., 2019). The maximum length of this species reported as a 2.4 m and the common length stated as 2.0 m and the common weight is a 70 kg (Nakamura, 1985). It is known that spawning of the *T. belone* occurs from spring to winter (Potoschi, 2000). Also, the Messina Strait (Italy) is expressed as the spawning area (Spartà, 1960; Cavaliere, 1962). Also, tagging studies have been applied to increase the ecological and biological knowledge of this species in the recent years (Arostegui et al., 2019; Malara et al., 2024).

This species is commonly found around Italian coasts (Nakamura, 1985; Di Natale et al., 2005) and rarely recorded in the eastern Mediterranean coasts and Aegean coasts of Türkiye (Bilecenoğlu et al., 2014). It is included to the annotated checklist of Lebanon (Bariche & Fricke, 2020) and recorded from Syrian coasts (Saad et al., 2024). Previously rare records in the Aegean Sea were reported from Müsellim Strait (North Aegean Sea), Izmir Bay (Central Aegean Sea) and Fethiye (South Aegean Sea) by Akyol et al. (2005, 2013, 2020), Rhodes Island (Corsini-Foka et al., 2020) and additionally in Karantina island, Izmir Bay after 10 years (Akyol, 2020).

The aims of the present study are to i) increase the knowledge of its biology by reveal some morphometric and meristic data, ii) report the northernmost distribution with this additional confirmed record.

### Materials and Methods

Two specimens of the Mediterranean spearfish were caught by a commercial fishery as bycatch with longlines from the Aegean Sea, Türkiye (Fig. 1a). These specimens were photographed and identified according to Nakamura (1986) and Robins & de Silyva (1960). 1st individual was caught with a pelagic longline on May 10, 2024, on the Babakale coast at a depth of 20 m (Coordinates: 39°28'51" N -

26°03'02" E, Fig. 1b). The technical properties of pelagic longline was expressed by fisherman as;

*“it has monofilament mainline with a diameter of 1.20 mm and the branchline was 2 m long and 0.80 mm in diameter. Each branchline was connected to the mainline at an interval of 4 m. The thick type was used with 8/0 sized flat hooks. The European squid (*Loligo vulgaris* Lamarck, 1798) was used as bait on the longline”.*

Due to upper jaw damaged, only lower jaw total length (LJFL) and total weight of the 1<sup>st</sup> individual were measured.

The 2<sup>nd</sup> individual was caught with a trammel net on May 23, 2024, on Mavra Island at a depth of 49 m (Coordinates: 39°57'55" N - 26°01'41" E, Fig. 1c). According to fisherman declaration, trammel net technically constructed by multifilament trammel nets with 42 mm mesh size (bar length) and with 160 mm mesh size outer panel. Following its capture, it was transferred to fish market in a fish box with ice. The meristic characteristics of this individual were counted in there. The morphometric measurements were taken in mm together with percentages from the LJFL, which taken as reference for Akyol (2020) and Hoolihan (2013). The total weight was recorded to the nearest 0.01 g. This individual (Fig. 1c) was dissected, following sex and maturity stages determined by macroscopic observation of gonads. The sexual maturity stages were determined according to the method described by Holden & Raitt (1974) as; Stage I (Immature), Stage II (Maturing), Stage III (Ripening), Stage IV (Ripe), Stage V (Spent). The gonad and stomach weight were recorded. The stomach dissected, dried on blotting paper and items were sorted by taxonomic level, counted and prey items identified in the laboratory (Froese & Pauly, 2024). The degree of prey digestion was determined according to the following scale (Vaske et al., 2004): ND, non digested prey; ID, initial digestion, with loss of parts of skin and fish scales; AD, advanced digestion, with loss of fins and muscular parts; and CD, complete digestion, only the remains of muscle, bones. Also, the total prey weight is recorded.



**Figure 1.** Record areas (a), the Mediterranean spearfish individual caught from Babakale coast (1<sup>st</sup> ind.) (b), the Mediterranean spearfish individual caught from Mavra Island (2<sup>nd</sup> ind.) (c).

## Results

The lower jaw total length of the 1<sup>st</sup> individual caught in Babakale coast was found as 1.7 m and its weight was measured as 30 kg. The morphometric measurements and meristic counts of 2<sup>nd</sup> individual from Mavra Island are shown in Table 1. Total, standard and fork length were measured from the start of the lower jaw of this individual due to damage to the upper jaw in the fishing operation. Morphometric measurements together with the percentage of the lower jaw total length are included in Table 1.

The 2<sup>nd</sup> individual was dissected (Fig. 2a) and the gonad weight of this individual was recorded as 146.37 g. This individual was determined to be female with a maturing stage due to an ovary about 1/2 the length of the body cavity (Fig. 2b).



**Figure 2.** Dissection of 2<sup>nd</sup> individual (a) and sex with maturity stage from gonad (b).

**Table 1.** Morphometric measurements, meristic counts and as a percentage of the lower jaw total length (LJFL) of the 2<sup>nd</sup> individual caught in the Mavra Island.

Morphometric measurements	mm	%LJTL
Lower jaw total length	1550	-
Lower jaw standard length	1435	92.6
Lower jaw fork length	1330	85.8
Body depth	212	13.7
Body girth	442	28.5
Head length	351	22.6
Eye diameter	40	2.6
Snout length	4	0.3
First dorsal fin base	177	11.4
Second dorsal fin base	60	3.9
First dorsal fin height	120	7.7
Second dorsal fin height	60	3.9
Distance between the 1 <sup>st</sup> . and 2 <sup>nd</sup> .dorsal fins base	90	5.8
First anal fin base	130	8.4
Second anal fin base	90	5.8
First anal fin height	136	8.8
Second anal fin height	41	2.6
Distance between the 1 <sup>st</sup> . and 2 <sup>nd</sup> . anal fins base	200	12.9
Distance between anus and the 1 <sup>st</sup> .anal fin	145	9.4
Pelvic fin height	185	11.9
Pectoral fin height	159	10.3
Predorsal length	410	26.5
Prepectoral length	395	25.5
Prepelvic length	340	21.9
Preanal length	742	47.9
Mouth width	80	5.2
Lower jaw length	190	12.3
Tail length	210	13.5
<b>Meristic counts</b>		
First dorsal fin rays	42	-
Second dorsal fin rays	6	-
First anal fin rays	11	-
Second anal fin rays	7	-
Pectoral fin rays	18	-
Pelvic fin rays	2	-
Total weight (g)	13150	-
Gonad weight (g)	146.37	-
Stomach weight (g)	471.86	-
Total prey weight in stomach (g)	23.88	-

The digestion level of the prey items in the stomach content of the 2<sup>nd</sup> individual were determined as advanced digestion stage, and complete digestion phase (Fig. 3a). The total prey weight was measured at 23.88 g in the stomach. It contained one type of prey item belonging to garfish

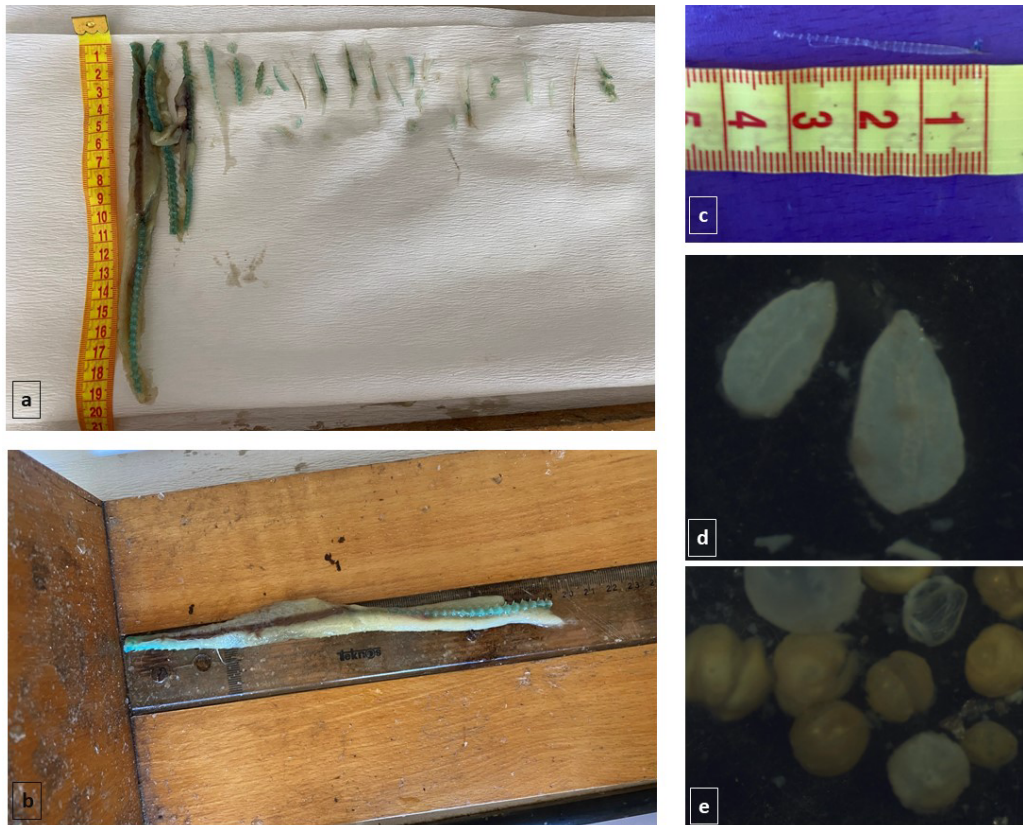
(*Belone belone* (Linnaeus, 1761)) juvenile and adults (Fig. 3b, 3c). 20 pieces of garfish extremities, 2 pieces of garfish otoliths with 0.0102 g and 16 pieces of garfish eyes with 0.912 g were determined in the stomach (Fig. 3a).

### Discussion

Although it is defined as highly migratory fish species, *T. belone* mostly distribute around Tyrrhenian Sea. The last studies revealed important evidences related horizontal and vertical distribution of *T. belone*, with using spatial data of pop-up satellite archival transmitting (PSAT) X-tags (Malara et al., 2024). In this study, authors revealed seasonal migrations of the species, which showed important variations. The results of that study showed that *T. belone* did not prefer to head towards Adriatic Sea or western Mediterranean Sea, although released from Messina Strait regardless of season and stated that it can be reach North Aegean Sea in during fall and winter. They stated that it prefers to migrate closer areas from natal habitat (Tyrrhenian Sea) in the summer but not achieved any data in the Spring. Our results reveal two different *T. belone* individuals in the North Aegean Sea, which both of them caught in the Spring. Thus, these results may have filled a gap of the Malara et al. (2024)'s study, if all individuals migrate from Tyrrhenian to Aegean Sea. Additional tagging studies should be performed from North Aegean Sea to understand the most concrete migration pathways.

The confirmed records of the present study reveal the northernmost distribution of this species. In the scientific literature, no valid distribution data from the Marmara Sea and the Black Sea. The low saline waters of these areas should pose a spatial migration barrier for *T. belone*. Also, Arostegui et al. (2019) stated that *T. belone* prefer to distribute the marine waters ranged between 26 °C and 28 °C, whereas it can be distributed up to 14.2 °C. Thus, salinity and *B. belone* distribution and abundance may be a major determinant of its spatial distribution.





**Figure 3.** Stomach contents (a) and advanced digestion of *Belone belone* (b) and juvenil *B. belone* (c), complete digestion of *B. belone* with otoliths (d) and *B. belone* with eyes (e).

The Mediterranean spearfish is caught incidentally or bycatch, especially in driftnet and longline fisheries (Nakamura, 1985; Collette et al., 2023). In this study, two individuals were caught using trammel net and a longline at depths of 20 and 49 m. Malara et al. (2024) also reported shallower migration road of *T. belone*. The findings of the present study support the findings.

The lower jaw total length and weight of the 1<sup>st</sup> and 2<sup>nd</sup> individual measured as a 1.7 m and 30 kg, and 1.55 m and 13.15 kg, respectively. The morphometric measurements, meristic counts and percentage of LJFL were determined to be nearly the same in the study conducted around Syrian waters (Saad et al., 2024). Collette et al. (2023) emphasized that the maximum size of this species exceeds 2.4 m in body length and 70 kg in weight. Akyol (2020) reported that one individual with total length of 176 cm (26 kg) caught in 72 mm stretched mesh size trammel net at nearly the same depth in the Aegean Sea. Also, Akyol et al. (2013) and Akyol et al. (2020) reported that 158 cm LJFL and 19 kg individuals of

the Mediterranean spearfish had been caught in a trammel net and longline in the Aegean Sea. The length and weight data shows similarities between the previous studies.

The stomach content of the *T. belone* individual showed a single prey species, which was identified as *B. belone*. In the previous studies, similar findings revealed for *B. belone* predation. A 33.9 %F (Frequency of occurrence) and 39.6% of IRI (index of relative importance) of the *T. belone* diet arised from *B. belone* item (Romeo et al., 2009). Similarly, 33.2% IRI was detected by Castriota et al. (2008) in the diet of *T. belone*. It can be thought that this situation mainly related with restricted vertical migration of *T. belone* and feeding habit above the thermocline (Romeo et al., 2012). Besides, 1st. *T. belone* specimen in the present study was caught by pelagic longline, which baited with European Squid, *Loligo vulgaris*. Romeo et al. (2012) stated that Cephalopods were important prey items for pelagic top predators such as *T. belone*. Castriota et al. (2008) detected a 12.9 %IRI of the diet of *T. belone* as total Cephalopods.

Thus, the pelagic longline hooks baited with the squid or octopus may be effective of the increase of bycatch ratio of the *T. belone*.

Salcedo-Bojorquez & Arreguin-Sanchez (2011) reported that the first maturity length of the Mediterranean spearfish was 150 cm LJFL and 2 years. In the present study, the female individual caught almost the same size, with its developing gonads. This finding supports the findings of the authors.

The knowledge on the biology, ecology and behaviour of *T. belone* has increased with increasing tagging studies in recent years (Arostegui et al., 2019; Malara et al., 2024). But there is still a lack of information regarding fish stock capacity, fishing pressure, population dynamics, fecundity, mortality etc. In addition to known spawning areas in the Messina Strait, Italy (Spartà, 1960; Cavaliere, 1962), new reproduction areas may occur with tagging studies in the Mediterranean Sea.

As a result, the records of the *T. belone* in the present study prove the expansion of its distribution towards North in the Aegean Sea. Additionally, there are speculations among fishermen with incidental catches of this species that one individual on Gökçeada Island and two individuals on Bozcaada Island were caught in the same sampling period, in the North Aegean Sea. This predator species may become more common and it may be occurred in the Marmara Sea in the near future. So, all notes about this rarely observed species are important in terms of understanding its ecological and biological knowledge.

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### Ethical Approval

The study was conducted by collecting the fish samples in dead conditions. An ethical approval is not required for the period during which the study was conducted.

### Conflicts of Interest

The authors declare that they have no conflict of interest.

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### References

- Akyol, O., Erdem M., Ünal, V., & Ceyhan, T. (2005). Investigations on drift-net fishery for swordfish (*Xiphias gladius* L.) in the Aegean Sea. *Turkish Journal of Veterinary and Animal Sciences*, 29, 1225-1231.
- Akyol, O., Aydın, I., Gülşahin, A., & Kara, A. (2013). Records of three uncommon fishes from Izmir Bay (Aegean Sea, Turkey). *Journal of Applied Ichthyology*, 29, 925-926. <https://doi.org/10.1111/jai.12173>
- Akyol, O. (2020). Additional record of Mediterranean spearfish, *Tetrapturus belone* Rafinesque, 1810 (Istiophoridae) from Izmir Bay (Northern Aegean Sea). *COMU Journal of Marine Science and Fisheries*, 3(2), 146-148. <https://doi.org/10.46384/jmsf.814214>
- Akyol, O., Ceyhan, T., & Capape, C. (2020). The second record of marlin sucker, *Remora osteochir* (Echeneidae) from the Turkish waters (Eastern Mediterranean Sea). *FishTaxa*, 17, 12-14.
- Arostegui, M. C., Braun, C. D., & Gaube, B. (2019). Movement and thermal niche of the first satellite-tagged Mediterranean spearfish (*Tetrapturus belone*). *Fisheries Oceanography*, 28, 327-333. <https://doi.org/10.1111/fog.12413>
- Bariche, M., & Fricke, R. (2020). The marine ichthyofauna of Lebanon: an annotated checklist, history, biogeography, and conservation status. *Zootaxa*, 4775(1), 1-157. <https://doi.org/10.11646/zootaxa.4775.1.1>
- Bilecenoğlu, M., Kaya, M., Cihangir, B., & Çiçek, E. (2014). An updated checklist of the marine fishes of Turkey. *Turkish Journal of Zoology*, 38(6), 901-929. <https://doi.org/10.3906/zoo-1405-60>
- Cavaliere, A. (1962). *Notizie su biologia e pesca di Tetrapturus belone* Raf. *Boll. Pesca Piscic. Idrobiol.* XV (2).
- Castriota, L., Finoia, M. G., Campagnuolo, S., Romeo, T., Potoschi, A., & Andaloro, F. (2008). Diet of *Tetrapturus belone* (Istiophoridae) in the central Mediterranean Sea. *Journal of the Marine Biological Association of the United Kingdom*, 88(1), 183-187. <https://doi.org/10.1017/S0025315408000106>

- Collette, B. B., & Graves, J. (2019). *Tunas and billfishes of the world*. Johns Hopkins University Press, Baltimore, Maryland.
- Collette, B. B., Di Natale, A., Graves, J., Pohlot, B., & Schratwieser, J. (2023). *Tetrapturus belone*. The IUCN Red List of Threatened Species 2023: e.T170334A204737590. <https://dx.doi.org/10.2305/IUCN.UK.2023-1.RLTS.T170334A204737590.en>
- Corsini-Foka, M., Insacco, G., & Zava, B. (2020). Occurrence of *Tetrapturus belone* Rafinesque, 1810 in the waters of Rhodes, Eastern Mediterranean. In Gerovasileiou, V., Akyol, O., Al-Hosne, Z., Alshikh Rasheed, R., Ataç, E., Bello, G., Cetković, I., Corsini-Foka, M., Crocetta, F., Denitto, F., ... & Zava, B. (2020). New records of rare species in the Mediterranean Sea (May 2020). *Mediterranean Marine Science*, 21(2), 340-359. <https://doi.org/10.12681/mms.22148>
- Di Natale, A., Mangano, A., Celona, A., & Valastro, M. (2005). Size frequency composition of the Mediterranean spearfish (*Tetrapturus belone*, Rafinesque) catches in the Tyrrhenian Sea and in the Strait of Messina in 2003. Collective Volume Scientific Papers ICCAT 58, 589–595 pp.
- Di Natale, A., Piccinetti, C., Addis, P., Garibaldi, F., & Tinti, F. (2022). *Comprehensive Italian annotated bibliography on the Mediterranean spearfish (Tetrapturus belone, Rafinesque, 1810), and on other billfish and Spearfish Species*. In Italian Annotated Bibliography of Tuna, Tuna-like and Billfish Species (pp. 799-850). Cham: Springer International Publishing.
- Froese, R., & Pauly, D. (2024). *FishBase, World Wide Web electronic publication*. [www.fishbase.org](http://www.fishbase.org), version (02/2024).
- Holden, M. J., & Raitt, D. F. S. (1974). *Manual of fisheries science. Part 2. Method of resource investigation and their application*. FAO Fisheries Technical Paper No. 115(1). Rome, Italy. 214 pp.
- Hoolihan, J. (2013). *Longbill Spearfish*. The Manual of International Commission for the Conservation of Atlantic Tunas. 1st Edition. 165-172 pp.
- Malara, D., Battaglia, P., Arostegui, M. C., Dale, J. J., Block, B. A., Braun, C. D., Brogna, M., Greco, S., & Romeo, T. (2024). Satellite tagging insights into the seasonal movements and behavior of Mediterranean spearfish (*Tetrapturus belone*, Istiophoridae). *Frontiers in Marine Science*, 11, 1362169. <https://doi.org/10.3389/fmars.2024.1362169>
- Nakamura, I. (1985). *FAO species catalogue. Billfishes of the world. An annotated and illustrated catalogue of marlins, sailfishes, spearfishes and swordfishes known to date*. FAO Fish. Synop. Rome, 125(5), 65 pp.
- Nelson, J. S. (1994). *Fishes of the World*, 3rd ed. John Wiley & Sons, Inc., New York, 600 pp.
- Potoschi, A. (2000). Aspetti biologici di *Tetrapturus belone* (Raf., 1810) nell'area dello Stretto di Messina. *Biologia Marina Mediterranea*, 7, 819-824.
- Robins, C. R., & de Sylva, D. P. (1960). Description and relationships of the longbill spearfish, *Tetrapturus belone*, based on western North Atlantic specimens. *Bulletin of Marine Science*, 10(4), 383-413.
- Romeo, T., Consoli, P., Castriota, L., & Andaloro, F. (2009). An evaluation of resource partitioning between two billfish, *Tetrapturus belone* and *Xiphias gladius*, in the central Mediterranean Sea. *Journal of the Marine Biological Association of the United Kingdom*, 89(4), 849-857. <https://doi.org/10.1017/S0025315408002087>
- Romeo, T., Battaglia, P., Pedà, C., Perzia, P., Consoli, P., Esposito, V., & Andaloro, F. (2012). Pelagic cephalopods of the central Mediterranean Sea determined by the analysis of the stomach content of large fish predators. *Helgoland Marine Research*, 66(3), 295-306. <https://doi.org/10.1007/s10152-011-0270-3>
- Saad, A., Khrema, L., Alnesser, A., Barakat, I., & Capapé, C. (2024). First substantiated record of mediterranean spearfish *Tetrapturus belone* (Istiophoridae) from the Syrian Coast. *Thalassia Salentina*, 45, 11-16. <https://doi.org/10.1285/i15910725v45p11>
- Salcedo-Bojorquez, S., & Arreguin-Sanchez, F. (2011). An exploratory analysis to identify reproductive strategies of billfishes. *Journal of Fisheries and Aquatic Science*, 6(6), 578-591. <https://doi.org/10.3923/jfas.2011.578.591>
- Spartà, A. (1960). Biologia e pesca di *Tetrapturus belone* Raf. e sue forme post-larvali. *Boll. Pesca Piscic. Idrobiol.*, XV (1), 20-24 pp.
- Vaske, T. Jr., Vooren, C. M., & Lessa, R. P. (2004). Feeding habits of four species of Istiophoridae (Pisces: Perciformes) from north eastern Brazil. *Environmental Biology of Fishes*, 70, 293–304. <https://doi.org/10.1023/B:EBFI.0000033345.53182.b9>